SEEDS

INPUTS OF THE FUTURE

Grain Growers

About GrainGrowers

GrainGrowers is a national organisation working to enhance the profitability and sustainability of Australian grain farmers. GrainGrowers achieves this through focus areas of policy and advocacy, grower engagement, thought leadership and active investment in future focused activities for all growers. Australian growers are at the heart of all that GrainGrowers do and the focus of GrainGrowers work.

About the series *Inputs of the Future*

Following the success of the Inputs Roundtable held by GrainGrowers in March 2023, GrainGrowers has released a series of deep dive reports into farm inputs.

This fourth edition focuses on seed

With fertiliser, agricultural chemicals and fuel covered in the first three editions, this final edition focuses on seed. This series is designed to serve many stakeholders including growers, government policy makers and industry.

The aim of this report is to examine the current state of Australia's seed supply and breeding pipeline, followed by a more in-depth analysis of what the future of seed genetics and breeding could look like. These insights are intended to inform government policy making and regulation, as well as being an informative guide for Australian grain growers.

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Australian grain growers face intense global competition coupled with the challenges of producing grain in a highly variable climate, which means access to the latest crop genetics and technology is critical for competitiveness.

Field of gold – Debra Charlton

EXECUTIVE SUMMARY

Australian grain growers are in a contest to obtain and deploy the very latest crop genetics and technology to remain globally competitive. Having access to the best crop genetics for our conditions and to meet market requirements allows grain growers to increase their resilience to a changing climate, increase profitability and contribute towards better environmental outcomes.

Breeding a new crop variety can take over a decade in some circumstances with hundreds of glasshouse and paddock trials to select the strongest performing lines, then quality evaluation, seed bulk up and commercialisation. A successful variety needs to produce grain that meets market and quality requirements, provide consistent yields, and tolerate a variety of seasonal conditions and environmental pressures, including pests and diseases.

There is a pressing need for government, the grains industry and supply chain to work together to ensure Australia has the systems and regulatory frameworks in place so that growers can continue to have timely access to new high performing varieties. The grains industry needs a regulatory environment that supports innovation. The regulatory environment needs to support timely access to innovative crop genetics and encourage sustained investment in Australia's breeding programs to empower growers and breeders in their quest for agricultural sustainability and global competitiveness.

Spraying day – Marlee Langfield

Australia's plant breeding system

A key element of Australia's crop breeding effort relates to the licencing arrangements allowed by the *Plant Breeders Rights (PBR) Act 1994*. Plant Breeders Rights (PBRs) are a way of protecting the intellectual property rights of plant breeders, and the system is managed by IP Australia.

These licencing arrangements mean that the cost of breeding programs can be recouped through End Point Royalties (EPR), as well as other mechanisms including bag royalties and closed loop marketing. EPRs, a fee that growers pay to produce and harvest a variety, fund many crop breeding programs for major crops, including wheat and barley. The EPR system, which was developed in Australia, drives competition between breeders to develop crop varieties that deliver the agronomic, yield and quality traits demanded by growers. Australia's plant breeding system ensures there are continued gains in the performance of Australian varieties, and that resistance to plant diseases like rust can be introduced to match the evolution and introduction of new pathogens.

[1] Cultivating success: Bridging the gaps in plant breeding training in Australia, Canada, and New Zealand - Egan - Crop Science - Wiley Online Library

The Australian plant breeding sector has remained strong at a time when other countries have seen a decline in plant breeding efforts. A survey of 278 public sector plant breeding programs in the United States found that many were short on funding, losing staff due to retirement and lacked succession plans. It is important to note that even with a strong foundation in plant breeding there are reported challenges with shortages of trained plant breeders globally, as highlighted in a recent CSIRO report[1]. It is important that Australia's system of PBRs and the framework that supports it, is updated and reviewed to ensure it is fit for purpose. In recent years there have been growing concerns and mounting evidence that royalties are not being paid, and an increasing risk that companies will reduce investment in the development of new varieties.[2] However, royalty collection mechanisms in some instances are complex and time consuming for growers, also contributing to lower compliance.

Plant breeding is a high technology business, requiring significant laboratory, computing and data management resources to track and screen tens of thousands of potential new varieties through the breeding and evaluation process. The use of molecular markers, in addition to other biotechnologies such as new breeding technologies and genetically modified traits, is both speeding up the crop breeding process and presenting new opportunities for Australian growers.

[2] Australian plant breeders' rights system undergoes major overhaul - ABC News

Windrowing – Isabel Burkinshaw

Crop breeding's transition from a public to a private industry

Crop breeding in Australia has undergone a significant evolution over the last 30 years. Until the late 1980s, most funding for plant breeding in Australia was provided by federal and state governments. These public funds were then allocated to state departments of agriculture, universities, and a select number of research institutes specifically for the advancement of breeding new plant varieties. These government entities accounted for over 90% of the total expenditure on agricultural research during this period. Since the 1990's and the advent of PBR there has been a shift away from public funding and an increase in private breeding activities in major crops.

Public and grower funded breeding efforts continue through the Grains Research and Development Corporation (GRDC) for chickpea, faba bean, field pea, lentil, milling oats, mungbean, peanut, soybean and vetch. GRDC also supports a range of work on pre-breeding activities that contribute to the breeding of major crops, including wheat, barley, canola, sorghum, oats, durum and lupins, through the delivery of traits that can better deal with variable conditions, improve disease and pest resistance and improve grain quality. However, the actual breeding of these major field crops is undertaken by commercial entities and is not generally supported through the GRDC.

[3] Breeding investments – GRDC Investments

EPR (End Point Royalty):

EPR is a payment system where royalties are paid to plant breeders based on the sale of the harvested product rather than on the seed itself. This model helps ensure that breeders receive compensation when their varieties are grown and sold, promoting continued innovation.

PBR (Plant Breeders' Rights):

PBR is a form of intellectual property protection that grants plant breeders exclusive rights to propagate and sell new plant varieties. This incentivises innovation in plant breeding by ensuring that breeders can benefit financially from their creations.

CRISPR Technology:

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a groundbreaking gene-editing technology that allows scientists to modify DNA with precision. It enables targeted changes to an organism's genetic code, making it a powerful tool for improving crop traits, enhancing resistance to diseases, and addressing food security challenges.

Supporting new variety development

As mentioned previously, the increased knowledge of plant genetics coupled with the application of a range of technologies has transformed plant breeding into a highly technical business and there are significant resources required to fund breeding programs. The cost structures of the different breeding companies vary, as does the complexity of developing the different mixes of traits in new varieties. Each company competes in the market to develop varieties that best meets the needs of a grower. Income earned needs to be re-invested by these companies to fund the development of new varieties and the supporting infrastructure they require.

There are many models for paying for the development of a new variety. Generally, they either relate to an upfront cost when purchasing the seed or paying through an EPR once the crop has been harvested. There are advantages and disadvantages of both.

Upfront payment for seed

For some plant varieties, primarily hybrid plant varieties, the cost of breeding is included in the price of the seed which typically makes the seed more expensive. This works as a charging mechanism for hybrid varieties because the traits of hybrids are not carried through into the seed produced, requiring growers to regularly purchase new seed to benefit from the hybrid traits. Hybrid varieties also express 'hybrid vigour' which results in additional yield, and uniformity in growth and flowering, which can provide significant advantages over traditional varieties.

Including the cost of breeding in the upfront price for the grain reduces complexity in collecting payment for breeding from growers, however growers carry significant risk if the crop fails because of this upfront cost. For this reason, hybrid varieties tend to be grown in regions with reliable seasonal conditions where growers are less likely to have failed crops. Hybrid crops include canola, sunflower, sorghum and maize and historically have not included cereal grains. However, recent developments in breeding have led to the first commercial release of a hybrid wheat variety in the United States[4].

[4] Hybrid Wheat | AgriPro Wheat

End point royalties

The EPR system enables the collection of royalties, to pay for plant breeding once the crop has been harvested. When a plant breeder develops a new variety, they establish a PBR for the variety. Under the current system growers complete a Harvest Declaration recording the EPR varieties grown, and this is reconciled by the variety owners and their EPR managers. This is usually completed between February and May following the cropping season.

Participating grain traders either deduct the royalty directly or provide reports on grain purchases to assist in the collection of EPR by the variety owners and their EPR managers. This system is suited to open pollinated (OP) varieties where seed remains 'true to type' allowing seed from the parent crop to be kept by the grower and used to plant to following year's crop. This system requires growers to keep records of crop varieties and production, but it provides the flexibility for the grower to keep seed and pay the breeder based on what is harvested. This is of a particular advantage in regions where seasons are less reliable and there is substantial risk in paying the cost of seed 'up front'. The market driven nature of EPR's incentivises breeders to produce high-performing open-pollinated (non-hybrid) varieties, ensuring continual advancements in agricultural productivity.

The integrity of the current EPR system relies on farmer records. Over recent years there have been reports of poor compliance with EPR arrangements in some regions, requiring breeders to increase compliance efforts including audits. This has led to calls by plant breeders to review the PBR arrangements to make reporting and compliance more straight forward. Growers have also called for mechanisms that would allow more simplified and timely reporting of EPR and reduce the administrative burden on their businesses. A strong system that better aligns with business practises will ensure continued future investment in plant breeding and therefore new and better crops for growers.

Why does Australia need new varieties?

New crop varieties play a crucial role in the Australian grain production sector in the context of adapting to an ever-evolving landscape of consumer demands, global markets and environmental challenges. Australia has developed varieties of wheat bred for the Japanese noodle market that meet specific quality requirements related to colour and end-product performance. In recent years the development of chickpea and lentil varieties that are better adapted to Australian conditions has allowed growers to diversify their cropping options and expand these markets.

With changing weather patterns and growing seasons, there's a growing demand for diversity in crop varieties that can take advantage of different seasonal conditions. Shorter season varieties allow growers to plant and harvest within a compressed timeframe, which can be particularly beneficial in regions with shorter growing seasons or unpredictable weather patterns. Longer season varieties allow farmers to take advantage of late autumn storms, allowing early crop establishment. This flexibility through increased choice helps growers manage risks associated with variable weather conditions and optimise their production cycles.

Moreover, the development of new drought-tolerant varieties can help growers withstand periods of water scarcity along with heat-tolerant varieties which can cope with higher temperatures. The gains already made from plant breeding to produce improved yields and manage seasonal conditions have been significant[5]. According to a study published in Nature Plants in 2018, genetic improvements accounted for approximately 70% of the yield gains in wheat over the past century, with the remaining 30% attributed to agronomic practices and other factors. Additionally new varieties resistant to pests and diseases help reduce reliance on chemical pesticides, promoting sustainable farming practices.

New varieties may target specific traits or a group of traits which aims to improve crop yield and productivity, allowing growers to produce more food on the same amount of land. Varieties may also be developed with 'built in' resistance to pests and diseases not currently present in Australia to avoid crops being impacted by high-risk biosecurity incursions. Higher-yielding varieties help meet the growing demand for food, feed, fibre and biofuels while minimising the environmental footprint of agriculture. Moreover, improved crop varieties often require fewer inputs such as water, fertilisers, and pesticides, resulting in cost savings for farmers and reducing environmental impact.

Having access to the latest innovations in seed varieties and technology ensures Australia maintains a leadership position globally, maintaining competitive advantage and adapting to increasing climate change challenges.

[5] Fischer, R.A. (2018). Understanding the contribution of breeding to yield gains in wheat. Nature Plants, 4(11), 779-780. https://doi.org/10.1038/s41477-018-0285-4

THE PLANT BREEDING PIPELINE

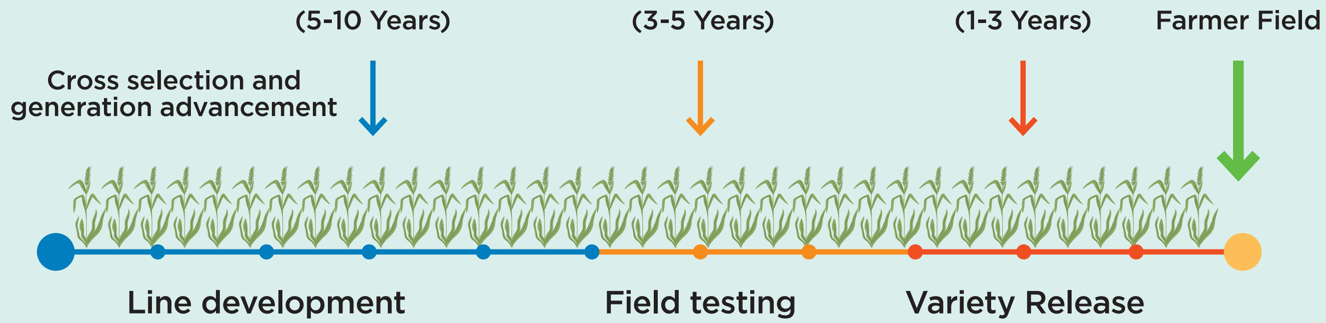
The plant breeding process is often referred to as a pipeline. At any time within a breeding program there can be thousands of different lines in development going through the process of being trialled, selected and cross bred to generate a suitable variety, at which point seed companies play a role in bulking up and distributing the seed to growers.

How does plant breeding work

In general, the grain breeding process begins with identifying key traits like yield potential, disease resistance, and stress tolerance. Breeders then collect diverse germplasm to access genetic diversity and initiate hybridisation also known as crossbreeding. This creates a new variety with a combination of desirable traits. Offspring from crosses undergo field evaluations to select superior lines and undertake testing across different environments.

Selected lines are rigorously evaluated in field trials to assess performance and adaptability, with data analysis guiding the identification of promising varieties. Successful varieties are released for commercial cultivation, with seed companies distributing seeds to farmers.

Timeline for conventional crop breeding



Source: Breeding More Crops in Less Time: A Perspective on Speed Breeding (mdpi.com)

International links to plant breeding

Australia's major crops were first cultivated overseas, and through breeding programs have been adapted to Australian conditions. Therefore, international linkages are fundamental to the success of the Australian grain industry and help to underpin breeding efforts. Breeding programs often have international links, and pre-breeding work to identify new and valuable traits. Adaptation to climate related stress and grain quality has links to international efforts in plant breeding and genetics. Examples of these connections include work with the CGIAR[6] (Consultative Group for International Agricultural Research) centres, including CIMMYT[7] (International Maize and Wheat Improvement Center). CIMMYT, based in Mexico, holds the world's largest germplasm collection of maize and wheat and undertakes work in partnership with the GRDC as well as the Australian Centre for International Agricultural Research (ACIAR).

[6] CGIAR: Science for humanity's greatest challenges
[7] CIMMYT

How does it happen?

Australia has a well-established agricultural research and breeding sector, including government research institutions, universities and private breeding companies which contribute to the development of new crop varieties suited to Australian conditions. This includes significant GRDC supported research on a range of pre-breeding activities that contribute to the delivery traits in a range of crops that allow greater tolerance to variable conditions, improved disease and pest resistance and improved grain quality. Plant breeders seek to deliver a variety with a unique combination of traits that either improve on the performance of existing varieties or meet a particular agronomic or market requirement. The process involves selecting parent plants with desirable traits, such as disease resistance, high yield, and environmental adaptability, and crossing them to produce new genetic combinations. Plant breeders draw on the genetic material they hold in their breeding programs, as well as genetic material identified through pre-breeding programs and potentially material held in other breeding programs.

Early morning wheat – Samantha Gilmour

Crop breeders seek various traits in commercial crop breeding to develop crop varieties that meet the needs of farmers and consumers in domestic and international markets. Some of the traits breeders may target are:

Yield:

Breeders aim to develop crops with high yield potential to increase productivity and profitability for farmers.

Disease Resistance:

Resistance to diseases caused by bacteria, fungi, viruses, and other pathogens is crucial for reducing crop losses and the need for chemical inputs.

Pest Resistance:

Resistance to pests such as insects and nematodes helps protect crops from damage, reducing the reliance on pesticides.

Drought Tolerance:

With increasing water scarcity and climate change, crops with improved drought tolerance can thrive in regions with limited water availability.

Heat Tolerance:

Heat-tolerant crops can withstand high temperatures, reducing yield losses during heatwaves and in regions experiencing warmer climates.

Cold Tolerance:

Crops adapted to cold temperatures can extend growing seasons and expand cultivation into cooler regions.

Salinity Tolerance:

Salinity-tolerant crops can grow in soils with high salt content, enabling cultivation in areas affected by soil salinisation.

Herbicide Tolerance:

Traits such as herbicide tolerance allow farmers to use specific herbicides to control weeds without harming the crop, simplifying weed management.

Quality Characteristics:

Breeders may focus on improving traits related to crop quality, such as taste, nutritional content, texture, colour, and shelf life, to meet consumer preferences and market demands.

Adaptation to Local Conditions:

Developing crop varieties adapted to specific environmental conditions, such as soil types, altitude, and photoperiod, can enhance performance and resilience in different regions.

Uniformity:

Breeders aim to produce seeds with uniform characteristics, ensuring consistent performance across fields and reducing variability in crop yields.

Early Maturity:

Early-maturing (sometimes referred to as 'short season') varieties allow for shorter production seasons, reducing the risk of yield losses due to adverse weather conditions or pest and disease pressure.

Stress Tolerance:

Traits that confer tolerance to various environmental stresses, including nutrient deficiencies, pH extremes, and heavy metal toxicity, can improve crop resilience and productivity.

Environmental Sustainability:

Breeders may prioritise traits that promote environmentally sustainable agriculture, such as reduced fertiliser requirements, nitrogen fixation, and carbon sequestration.

The use of biotechnology in plant breeding

Biotechnology refers to a suite of innovative technologies and a variety of applications that can be used in plant breeding. This includes the use of molecular markers to ensure target genetic traits have been successfully passed down through breeding, new breeding techniques and gene technology. With plant breeding requiring a significant investment of both time and resources, the application of biotechnology provides opportunities to reduce the time to bring a new variety to market, assist breeders to meet quality needs of markets, produce varieties that have agronomic advantages, improve sustainability outcomes and adaptation to local production environments and deliver yield benefits more quickly.

Biotechnology helps to deliver new opportunities to agricultural production systems and can provide benefits for Australian growers, the environment and consumers. The independent national regulators, the Office of the Gene Technology Regulator (OGTR) and Food Standards Australia New Zealand (FSANZ), play a vital role in ensuring confidence with the use of biotechnology. It is critical that regulation is science-based and responsive to new developments, including changes in technology, science and risk.

The use of new breeding technologies, including gene editing, has emerged as an important tool for plant breeding. The technologies allow precise changes to be made to the genome of a plant variety that take much longer to achieve, at much greater expense, when using conventional breeding techniques. However, to leverage these developments regulators must keep pace with rapidly emerging technologies, and Australian regulation keeps up with the international regulatory environment and can meet the expectations of markets. A regulatory environment that falls behind international standards will act as a disincentive to investment in this area and reduce the opportunity for innovation and developing market advantage.

The grain industry has an almost 20-year track record as stewards of gene technology. For example, genetically modified (GM) herbicide tolerant canola has been grown commercially in New South Wales and Victoria since 2008. Ultimately, successful adoption of any new technology, including biotechnology, by Australian growers requires regulatory and market acceptance and confidence in the integrity of supply chains to deliver the quality demanded by our customers. The industry has worked in partnership with the technology providers, the seed industry, farmers and grain handlers to manage the grain within the supply chain through to markets.

The development of GM crop varieties remains important for Australia. Canola remains the largest GM grain crop for Australia, and there are several other GM grain crops grown internationally including soybean and maize. Trials of various GM crop varieties are regularly undertaken in Australia to test their performance and the expression of new traits, including herbicide resistance and tolerance to insects and environmental stresses. In recent years GM wheat has been commercialised in Argentina, and it is expected that the quantity and diversity of GM crops produced internationally will continue to grow.

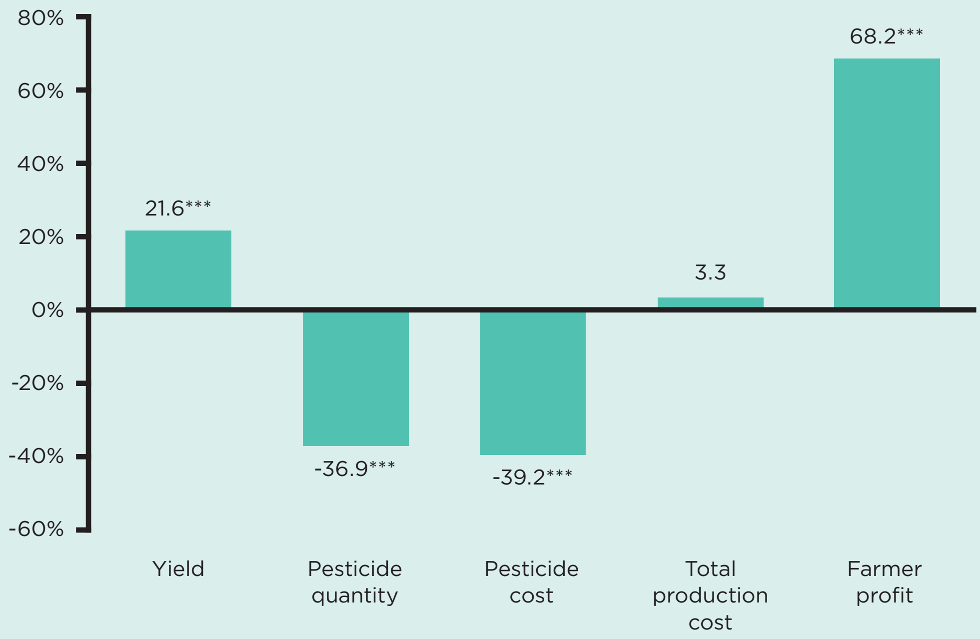
Tools to deal with future challenges

Genetically modified varieties provide Australian growers with a new generation of tools to deal with future challenges. In Australia, GM crops have been commercially grown since 1996 when Australian cotton farmers began the use of pest resistant varieties. As a result, in the 20 years post the domestic introduction of GM cotton there was a 92% reduction in pesticide use in Australian cotton farming systems[8].

GM varieties have become an indispensable tool for addressing unique agricultural challenges while ensuring sustainable food production. GM crops offer tailored solutions in much shorter breeding timeframes that enable growers to adapt to modern day pests, diseases and environmental stresses. By cultivating GM varieties engineered for traits like herbicide tolerance, drought tolerance, and disease and insect resistance, Australian farmers can reduce chemical usage, conserve water, and enhance yields in increasingly arid regions.

[8] biotech-aus-policy-snapshot.pdf (agriculture.gov.au)

Impacts of GM crop adoption



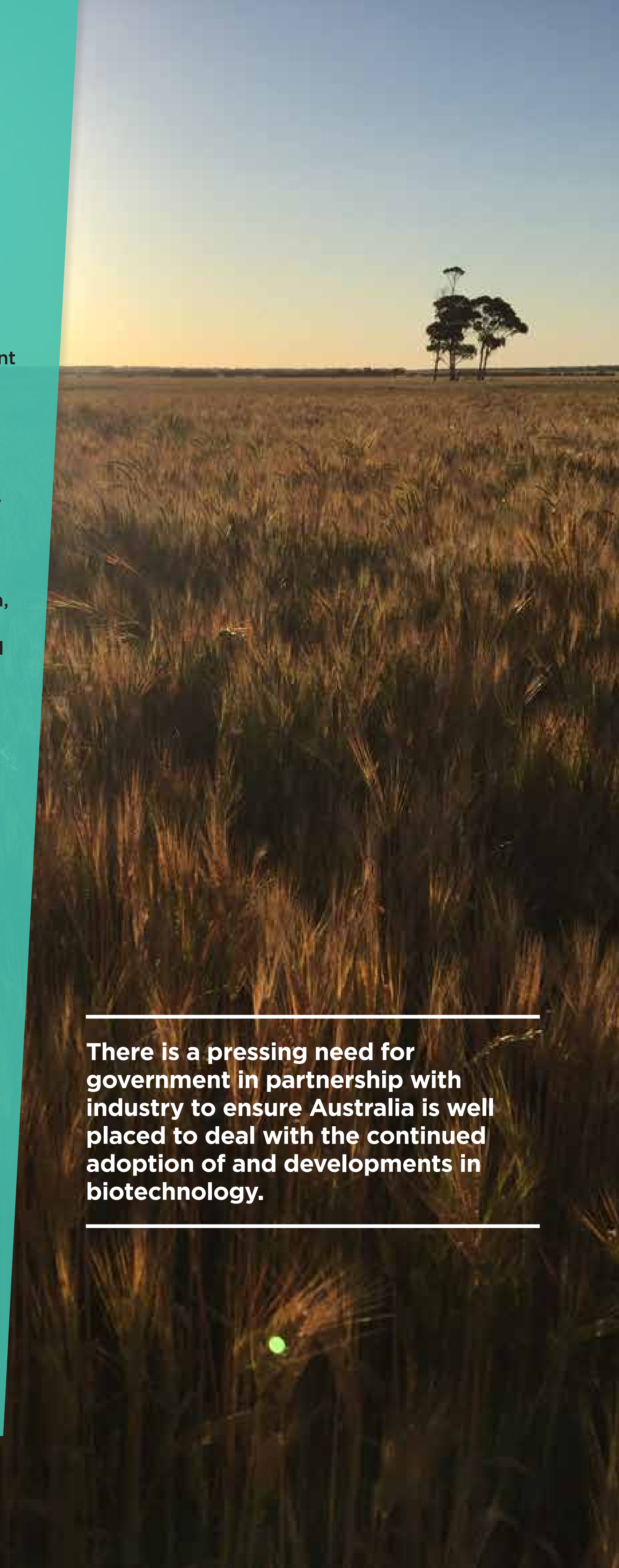
1. By 2018, GM crops across the world led to 37% less pesticide use, 22% increase in crop yields and a 68% increase in farmer incomes.
2. Cotton was Australia's first GM crop. Cotton was previously sprayed 12-17 times per year for insects, Bacillus thuringiensis (Bt) Cotton is only sprayed 1-2 times per year.
3. New CRISPR gene editing technology which targets the gene itself has resulted in non-GM plants that are resistant to some diseases and have improved food quality.

Source: Wilhelm Klumper, Matin Qaim, 2014
https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0111629&type=printable

HB4 wheat, a new opportunity from biotechnology?

The development of new crop varieties through the application of biotechnology, including GM crops, continues to occur in Australia and internationally. The development of HB4 wheat by Argentinian biotechnology company Bioceres is an example of the continued interest and work in this area. Several HB4 wheat varieties have been bred, and these incorporate genes from sunflower into the wheat which allow the crop to better withstand periods of low water availability compared to conventional wheat varieties. Currently food derived from HB4 grain has been approved in the United States, Australia, Colombia, Indonesia, New Zealand, Nigeria, South Africa and Thailand, although approval for its cultivation is currently restricted to Brazil and Argentina.

Bioceres is working in several markets to demonstrate the performance of the technology and potentially commercialise the technology more broadly. This includes seeking approvals to undertake trials in Australia. The Australian grains industry is following developments related to both GM grain and grain derived from the use of new breeding technologies with interest.



There is a pressing need for government in partnership with industry to ensure Australia is well placed to deal with the continued adoption of and developments in biotechnology.

Australia's regulatory environment, including biotechnology regulation and intellectual property protection, should facilitate the development and adoption of new technology, and not contribute unnecessary cost, time delay for market entry and risk in bringing a product to market. Regulation must be science-based, reflect best practice and be responsive to new developments, including changes in technology, science application and risk.

What are the current regulations for GM crops grown in Australia?

In Australia, the regulation of GM crops is overseen by several government agencies at the federal and state levels. The key regulatory framework includes:

Office of the Gene Technology Regulator (OGTR):

The OGTR is the national regulator for gene technology in Australia. It assesses applications for the release of GMOs into the environment, including GM crops, and monitors compliance with the *Gene Technology Act 2000* and corresponding regulations. The OGTR conducts risk assessments to ensure that GM crops are safe for human health and the environment before they are approved for commercial release.

Food Standards Australia New Zealand (FSANZ):

FSANZ is responsible for assessing the safety and nutritional quality of GM foods intended for human consumption. It evaluates applications for the approval of GM foods under the Food Standards Code, ensuring they meet safety and labelling requirements.

Department of Agriculture, Fisheries and Forestry (DAFF):

DAFF is responsible for managing imports of GM crops and products and ensuring compliance with quarantine regulations to prevent the introduction of pests and diseases.

State and territory governments:

In addition to federal regulations, individual states and territories may have their own legislation and regulations governing the cultivation and sale of GM crops. Some states have imposed moratoriums or restrictions on the commercial cultivation of GM crops, while others allow their cultivation under specific conditions.

Source: GM Crops: frequently asked questions | Waite Research Institute | University of Adelaide

Breeding to meet market demands

Potential markets are a key focus of any crop breeding process, with plant breeders examining the suitability of the grain for specific end-uses. Australia sells grain to a variety of markets that look for certain characteristics in grain that makes them suited to particular end-uses. Growers make choices about what varieties to grow based on the demand and price signals from buyers for grain suited to a customer as well as the suitability of growing conditions for these particular varieties. Examples of specific markets that breeders might target include:

Noodle wheat:

This is a white grained wheat with relatively soft kernel hardness. The key quality requirements for noodle wheats are excellent physical grain and milling quality with high flour pasting attributes, and specific flour colour and end product performance in the manufacture of udon noodles. Noodle wheat typically has a target growing protein range of 9.5% to 11.5%.

Durum wheat:

This is a hard-grained high protein wheat (over 13%) with intense yellow colour, nutty flavour and excellent cooking qualities. These wheats are ideal for pasta production.

Soft wheats:

These wheats have a low protein content (below 9.5%), low water absorption and produce a low strength dough. Historically they have been used for biscuit and cake production and are ideal for a range of Asian steamed bread products.

Malting barley:

Malting barley focuses on high germination energy and favourable enzyme activity. These traits ensure efficient malting processes and the production of high-quality malt for brewing and distilling.

The path to commercial release

Once a promising line has been identified in a breeding program, a process of testing and trials is undertaken to understand the performance of the variety and assess its performance under field conditions. There are many stages to this process, which are described below:

1. Preliminary Testing:

Once potential varieties are developed, they undergo preliminary testing in controlled environments such as research stations or experimental farms. This stage helps researchers assess the performance of the new varieties under different growing conditions and select the most promising candidates for further evaluation. In many cases this is done in partnership with growers on grower properties.

2. National Variety Trials (NVT) Trials:

Selected varieties are submitted to the NVT program, a collaborative effort involving government agencies, research institutions, and industry partners that is funded and coordinated by the GRDC. These trails are also closely watched and attended during field days by various farming systems groups and individual growers. Participation in the NVT by breeding programs is voluntary. NVT conducts multi-location field trials across various agro-climatic zones to evaluate the performance of new varieties under real-world conditions. Data collected from these trials include yield potential, disease resistance, quality attributes, and agronomic characteristics. These trials assess the performance of varieties and provide a benchmark against the performance of existing varieties. The information generated by these trials helps underpin grower choices on the adoption of varieties, including the suitability of the variety to their local conditions. Breeding programs will also undertake their own trials to understand variety performance under different conditions.

3. Data Analysis and Recommendation:

After the completion of internal trials as well as NVT trials, the collected data is analysed to determine the performance of each variety across different locations and seasons. Based on this analysis, plant breeders develop recommendations regarding the suitability of varieties for commercial cultivation in specific regions as well as the quality of the grain for particular end-uses.

4. Commercialisation:

Once the performance of a variety has been demonstrated, the plant breeder makes a commercial decision regarding its release. Seed companies are engaged to produce and distribute the seeds to farmers for cultivation, although this step is sometimes undertaken by the breeding company.

Throughout this process, collaboration between researchers, industry stakeholders including bulk handlers and marketers, and regulatory bodies is essential to ensure the development and adoption of new crop varieties that meet the needs of Australian growers and contribute to agricultural productivity and sustainability.

Did you know: Naming Grains Down Under and Beyond!

In Australia and around the globe, breeding companies and individuals get creative when it comes to naming new grain varieties. For example, 'Federation' wheat was celebrated for its resilience and high yield at the time; it was named to commemorate the centenary of Australia's federation in 1901, symbolising unity and progress. Meanwhile, 'Hawkeye' barley, released by the Queensland Department of Agriculture and Fisheries, evokes a sense of vigilance in farming. An interesting example is 'Schooner' barley, named after the vessels that transported prized South Australian grain to Britain and beyond a century earlier. GrainGrowers itself even has a variety 'Sunprime' wheat in honour of the organisation's 60th anniversary. Some companies even involve farmers in the naming process, turning it into a community celebration. Globally, names might pay homage to historical figures, places, or clever puns, making every variety not just a crop, but a story waiting to be told!

Seed supply

Once a variety has been identified for commercialisation, plant breeders need to bulk up seed to ensure suitable volumes are available for the market. This may involve contracting a seed company to produce seed. First generation seed produced for market must meet high quality standards to ensure that it meets specifications related to germination, genetic purity and physical standards such as size and weight. Typically, a grower using an open pollinated variety would purchase enough seed to plant out an area, potentially assess the performance of the variety, and then retain the seed produced to plant a subsequent crop. Growers would continue to use retained seed to plant subsequent crops. However, a grower using hybrid seed will purchase enough seed to grow an entire crop, which can create a significant demand for seed.

To meet market demands for hybrid seed, seed companies must forecast demand and begin production in the season prior to the seed being sold to growers. More information on this process is available on the **GrainGrower's website**[9]. Poor seasonal conditions in seed production areas coupled with high levels of demand, often in response to high international prices, can cause challenges for supply.[10] Some companies provide an annual update on seed production to assist growers planning their planting program and to inform the market of possible challenges in seed supply . In some cases, seed is bulked up internationally to manage the potential for poor seasonal conditions. In these situations, the imported seed can be delayed because of lengthy biosecurity requirements which can result in seed supply issues for growers.

[9] **Hybrid Canola Seed Supply Shortages | Building a more profitable and sustainable industry for Australian growers (graingrowers.com.au)**

[10] **February 2024 Canola Seed Supply Update | Nuseed Australia**

Summary

Australian grain growers face intense global competition coupled with the challenges of producing grain in a highly variable climate, which means access to the latest crop genetics and technology is critical for competitiveness. Cutting-edge crop genetics enhance growers' resilience to climate change, boost profitability, and foster better environmental outcomes. Developing a new crop variety is a lengthy process, spanning 8-12 years of rigorous trials and evaluations to meet market demands, yield consistency, quality standards, and adaptability to diverse environmental pressures.

There is a pressing need for government in partnership with industry to ensure Australia is well placed to deal with the continued adoption of and developments in biotechnology. This requires regular regulatory review and reform, and these processes need to be completed in a timely manner. This will ensure Australian definitions of these technologies harmonise with international developments. By facilitating a conducive regulatory environment, government will help to ensure Australia growers have timely access to innovative crop genetics, and growers and breeders will be empowered in their quest for agricultural sustainability and global competitiveness.

The application of biotechnology presents the opportunity for a 'step change' for Australian growers and their ability to deal with the immediate and future challenges presented by climate change and increased variation in weather patterns. The Australian grains industry is looking to clearly identify the roles of various stakeholders including growers, plant breeders, government, markets, the supply chain and manufacturers in the adoption of these technologies to ensure these important opportunities germinate.

The application of biotechnology presents the opportunity for a 'step change' for Australian growers and their ability to deal with the immediate and future challenges presented by climate change and increased variation in weather patterns.

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